Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Globalstar, Inc. Petition for Notice of Inquiry	)	RM-11808
Regarding the Operation of Outdoor U-NII-1	)	
Devices in the 5 GHz Band	)	

CONSOLIDATED REPLY OF GLOBALSTAR, INC.

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Executive Summary

Having taken over 800 individual noise measurements around the world since May 2014, Globalstar has provided comprehensive real world data documenting a substantial increase in the 5.1 GHz noise floor over North America since the Commission permitted higher-power, outdoor U-NII-1 operations. The few opponents to Globalstar's Petition provide no measurements or other empirical data of their own, even though most or all have known about Globalstar's concerns since at least November 2017.

Globalstar has geographically isolated the noise floor rise to North America, having conducted extensive measurements showing no noise increase over Mexico and Central America, Europe, Australia, or "blue ocean." The noise rise is happening only here, where unlimited, higher-power outdoor U-NII-1 deployments have been permitted.

Furthermore, Globalstar's technical consultant has considered all other potential sources of interference and concluded that no other operations could possibly be causing the consistent, widespread interference that Globalstar is measuring. Globalstar's comprehensive measurement data reveals that aggregate interference from numerous U-NII-1 devices is causing a consistent noise floor increase over the United States. Neither the Commission nor any commenter in this proceeding has identified any other plausible source of this interference.

In their filings, opponents highlight their current and future reliance on outdoor U-NII-1 operations, making it abundantly clear that the noise floor rise will continue unabated. As the Wi-Fi Alliance states, "initial implementations [are] still underway." If the Commission does not promptly investigate and explore remedies to this interference, the noise level will rise to a point where Globalstar's services will be seriously degraded.

Globalstar's products and services are used daily by its customers around the world for emergency communications, in many instances resulting in life-saving rescues. Given Globalstar's investment in a new constellation of satellites and ground infrastructure, it does and will continue to rely heavily upon its two-way communications platforms to keep people connected regardless of the availability of terrestrial networks.

In response to Globalstar's compelling evidence, a few parties suggest that the Commission look the other way and not open a proceeding to gather a complete factual record. Given its statutory obligation to protect licensed services and the Commission's 2014 commitment to take "corrective action" in response to any harmful interference to Globalstar MSS, it would be arbitrary and capricious for the Commission to capitulate to these opponents' demands. Instead, the Commission should expeditiously issue a Notice of Inquiry that investigates the noise floor rise at 5.1 GHz and creates the detailed record necessary for a long-term solution to this harmful interference.

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CONSOLIDATED REPLY OF GLOBALSTAR, INC.

I. Introduction and Summary

In its Petition for a Notice of Inquiry ("Petition"),[1] Globalstar, Inc. ("Globalstar") provided evidence of a significant noise floor rise in its feeder uplink spectrum. Globalstar also demonstrated that this rise was likely due to Unlicensed National Information Infrastructure ("U-NII") deployments at 5.1 GHz (the "U-NII-1" band) and that further deployments were likely to cause serious harm to Globalstar's MSS operations and customers, including public safety users. Numerous parties support the Petition and urge the Commission to issue a Notice of Inquiry ("NOI") to investigate the cause of the noise rise and to determine whether further steps are appropriate to protect Globalstar's MSS network from harmful aggregate interference from unlimited U-NII-1 deployments.[2] The few opponents to the Petition, meanwhile, fail to present

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[1] Petition for Notice of Inquiry of Globalstar, Inc., RM-11808 (May 21, 2018) ("Petition"); Public Notice, *Consumer & Governmental Affairs Bureau Reference Information Center Petition for Notice of Inquiry*, Report No. 3092 (rel. June 6, 2018).

[2] *See, e.g.*, Comments of the Satellite Industry Association at 2 ("Given the technical analysis in the record demonstrating the potential for harmful aggregate interference from outdoor unlicensed operations into the Globalstar system in the 5.1 GHz band, it is important that the Commission investigate and remedy any harmful interference into its satellite operations."); Comments of the National Public Safety Telecommunications Council at 5 ("[A] Notice of

any evidence rebutting the existence of the noise rise. Nor do they provide any plausible alternative cause for the noise rise. They merely attempt to poke holes in Globalstar's measurements and analysis of the cause of the noise rise. Those attempts fail to establish that an NOI is not appropriate here.

Opponents to the Petition also claim that an NOI would create "regulatory uncertainty." That is incorrect. The Commission's 2014 order permitting outdoor U-NII-1 operations explicitly stated that the Commission would take corrective action in response to any interference with Globalstar's satellites.[3] Opponents have known since 2014 that they may need to cease or modify their outdoor operations in the U-NII-1 band. In fact, an NOI would promote regulatory certainty by creating a record through which the Commission can determine the cause of the noise rise, so that it can decide whether, as the Commission contemplated in 2014, corrective actions are needed and opponents can know whether they need to modify their U-NII-1 deployment practices.

In this regard, Globalstar's request is notably modest. It asks only that the Commission issue an NOI to investigate the noise rise and to determine whether any regulatory action should be considered. Globalstar's extensive measurement data and sound technical analysis meet any reasonable evidentiary threshold for taking that modest step. Even if opponents' criticisms of Globalstar's measurements and analysis had any potential merit (which they do not), that should not deter the Commission from conducting its own investigation and making its own

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Inquiry or other mechanism to provide an 'after action report' on the cause of the rise in the noise floor and to assess what has gone well and what needs to be changed with spectrum sharing at 5 GHz.") ("NPSTC Comments"). (Unless otherwise indicated, all comments and oppositions cited herein were filed in RM-11808 on July 6, 2018.)

[3] *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band*, First Report and Order, 29 FCC Rcd 4127, ¶¶ 34-46 (2014) ("*2014 5 GHz Order*").

determination as to the causes and effect of the noise rise. The Commission should begin this investigatory process now, before harmful interference disrupts Globalstar's satellite offerings and jeopardizes public safety.[4]

II. The Commission Should Issue an NOI Regarding the Significant Noise Floor Rise at 5.1 GHz and Potential Harm to Globalstar's MSS Operations and Customers

Globalstar has provided unrebutted evidence of a significant noise floor rise at 5.1 GHz, and it has shown that the rise is likely due to unlimited U-NII-1 operations. Notably, Globalstar has detected this change only over North America, the sole area where outdoor U-NII-1 operations have so far been permitted. Globalstar has also presented compelling evidence that, over time, this rising noise floor will absorb substantial Globalstar subscriber capacity and degrade Globalstar's licensed services to public safety users and other customers. As set forth below, opponents to the Petition provide absolutely no empirical data to back up their claims that U-NII-1 devices are not the cause of the noise rise, and they fail to persuasively refute the analysis of Globalstar's technical consultant Roberson and Associates, LLC ("Roberson").

The Commission thus should issue an NOI to investigate this noise floor rise in order to fulfill its core obligation to ensure that unlicensed operations do not cause harmful interference to licensed services.[5] By releasing an NOI, the Commission can investigate the cause of the noise rise, develop a comprehensive factual record, and determine whether to take further

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[4] In its opposition, Cisco references the Commission's investigation of harmful interference to Terminal Doppler Weather Radars ("TDWRs") in the U-NII-2A and U-NII-2C bands and the *5 GHz Order*'s adoption of more restrictive technical rules for unlicensed operation in those bands to protect TDWR systems. Cisco Opposition at 5-6; *5 GHz Order* ¶¶ 61-86. The Commission can look to the process in those U-NII bands band for guidance as it determines its response to the threat of harmful aggregate interference to Globalstar's safety-of-life MSS operations.

[5] *See, e.g.*, 47 U.S.C. § 301; 47 C.F.R. § 15.5(b)-(c); *2014 5 GHz Order* ¶ 38 (acknowledging that "corrective action" would need to be taken if interference occurred).

regulatory action.[6] Significantly, the Commission has issued an NOI in numerous other circumstances where it sought to develop a more robust record before adopting specific rulemaking proposals in a Notice of Proposed Rulemaking.[7]

A. The Noise Floor at 5.1 GHz Has Risen Dramatically Since February 2017

In the Petition, Globalstar presented measurement data showing a 2 dB noise rise in the 5.1 GHz band since February 2017.[8] In contrast, opponents to the Petition do not submit *any* empirical data regarding this noise floor rise. While only Globalstar can conduct satellite measurements, these parties could have pursued alternative measurement techniques or other methods to collect and provide information on the source of the noise rise. However, they chose not to do so. As a result, Globalstar's numerous noise measurements over the past three plus years represent the only meaningful empirical data available to the Commission.

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[6] Under the Commission's rules, Globalstar needed only to provide "sufficient reasons" to initiate an NOI, which it has done. *See* 47 C.F.R. §§1.407, 1.430.

[7] *See, e.g., Location-Based Routing for Wireless 911 Calls*, PS Docket No. 18-64, Notice of Inquiry, FCC 18-32, ¶ 5 (rel. Mar. 23, 2018) (stating that "this *Notice of Inquiry* is the most appropriate initial step in evaluating" the transition from tower-based routing to location-based routing, as it "will allow for the development of a more complete record regarding the technical and operational implications, limitations, deployments, and best common practices of location-based routing and the costs and benefits of different location-based routing methods"); *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, 32 FCC Rcd 6373, ¶ 7 (2017) ("With this Notice of Inquiry, we hope to obtain relevant data and information . . . so that we can make more informed and specific proposals in any future proceedings."); *Revitalization of the AM Radio Service*, First Report and Order, Further Notice of Proposed Rulemaking, and Notice of Inquiry, 30 FCC Rcd 12145, ¶ 81 (2015) (addressing commenters' suggestions that the Expanded Band be opened up to more stations by issuing a Notice of Inquiry rather than including the topic in the accompanying Notice of Proposed Rulemaking, because "there are a number of procedural and practical decisions to be made before proposing rules for further utilization of that band. We believe that a more complete record is needed before proposing rules regarding further expansion of the 1605-1705 kHz band.").

[8] *Globalstar 5 GHz Noise Floor Measurement Description and Current Results* (May 21, 2018), attached as Appendix A to Petition ("Globalstar Measurement Report").

Globalstar's noise measurements, moreover, are methodologically sound and valid indicators of the ongoing noise rise at 5.1 GHz. Globalstar's satellite measurements of a 2 dB noise floor rise are consistent over the past eighteen months, as shown in Globalstar's chart attached to its measurement report.[9] From 2014 until the filing of the Petition, Globalstar performed almost 500 measurements over the United States from eight different satellites, one in each of its constellation's eight orbital planes. It continues to conduct these measurements (over thirty measurements since filing), and the results continue to confirm the noise floor rise.

As described in the attached technical exhibit from Roberson,[10] none of the opponents' criticisms of Globalstar's measurements has merit:

- *Calibration process.* Globalstar utilized a careful and comprehensive calibration procedure from late 2013 through early 2014 to establish the measurement capability on each of the eight satellites involved in the measurements. Contrary to opponents' claims, the calibration occurred while the satellites were in orbit and in operation, not on a "pre-launch" basis.[11]

- *Measurement in 1 dB increments.* Globalstar's measurement of the noise floor rise in 1 dB increments, with an accuracy of +/- 0.5 dB, correctly states this noise rise. A measured noise rise of 2 dB indicates an actual noise rise between 1.5 dB and 2.5 dB.[12]

- *Two-minute measurement periods*. Globalstar has to date performed 520 noise floor measurements from eight different satellites in order to assess the noise floor at 5.1 GHz over North America. The sheer number of measurements supports the reliability of this data. In addition, Globalstar has conducted these measurements at various times of day, further enhancing the reliability of these results.[13]

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9 Globalstar Measurement Report at A-3; *see also infra* at 7.

10 Roberson and Associates, LLC, *Technical Analysis of Comments to Globalstar Petition* (July 23, 2018), attached hereto as Exhibit A ("Roberson Exhibit").

11 *Id*. at 5-6.

12 *Id*. at 6-8.

13 *Id*. at 6-7. During conversations with NCTA representatives prior to Globalstar's filing of the Petition, NCTA requested that Globalstar take measurements at longer intervals while its satellites traverse North America in its entirety. Globalstar explained that such measurements are not commercially possible. For commercial and public safety reasons, Globalstar must limit

- *Variation between satellites*. The noise floor measurements across the eight Globalstar satellites have not "differed widely," as some opponents have claimed. As shown in the chart below, all eight satellites show a recent rise in the noise floor, consistent with increasing aggregate interference due to the proliferation of U-NII-1 devices. Six of the eight satellites have measured a 2 dB rise to date. While the transponders on two satellites have measured only a 1 dB rise so far, they will likely show a 2 dB rise (and higher) in the future as aggregate U-NII-1 emissions increase over time.[14]

- *Measurement over Lincoln, Kansas*. Globalstar conducts its noise measurements when its satellites are located approximately within a 300 mile radius of Lincoln, Kansas. Globalstar selected this location because it is the approximate center of the United States and would provide a representative noise floor level. The noise floor observed by each satellite stays at an elevated level as its coverage area traverses the United States.[15]

B. The Noise Floor Rise at 5.1 GHz Has Been Caused by Unlimited U-NII-1 Wi-Fi Transmissions

Globalstar has provided compelling empirical evidence that unlimited outdoor U-NII-1 Wi-Fi deployments are responsible for the noise floor rise at 5.1 GHz. Most notably, Globalstar has taken measurements across the world and has found a substantial rise in the noise floor only over the United States (where U-NII-1 outdoor operations are permitted) – not over Europe, Australia, Central America, the northern portion of South America, or "blue ocean" (where such

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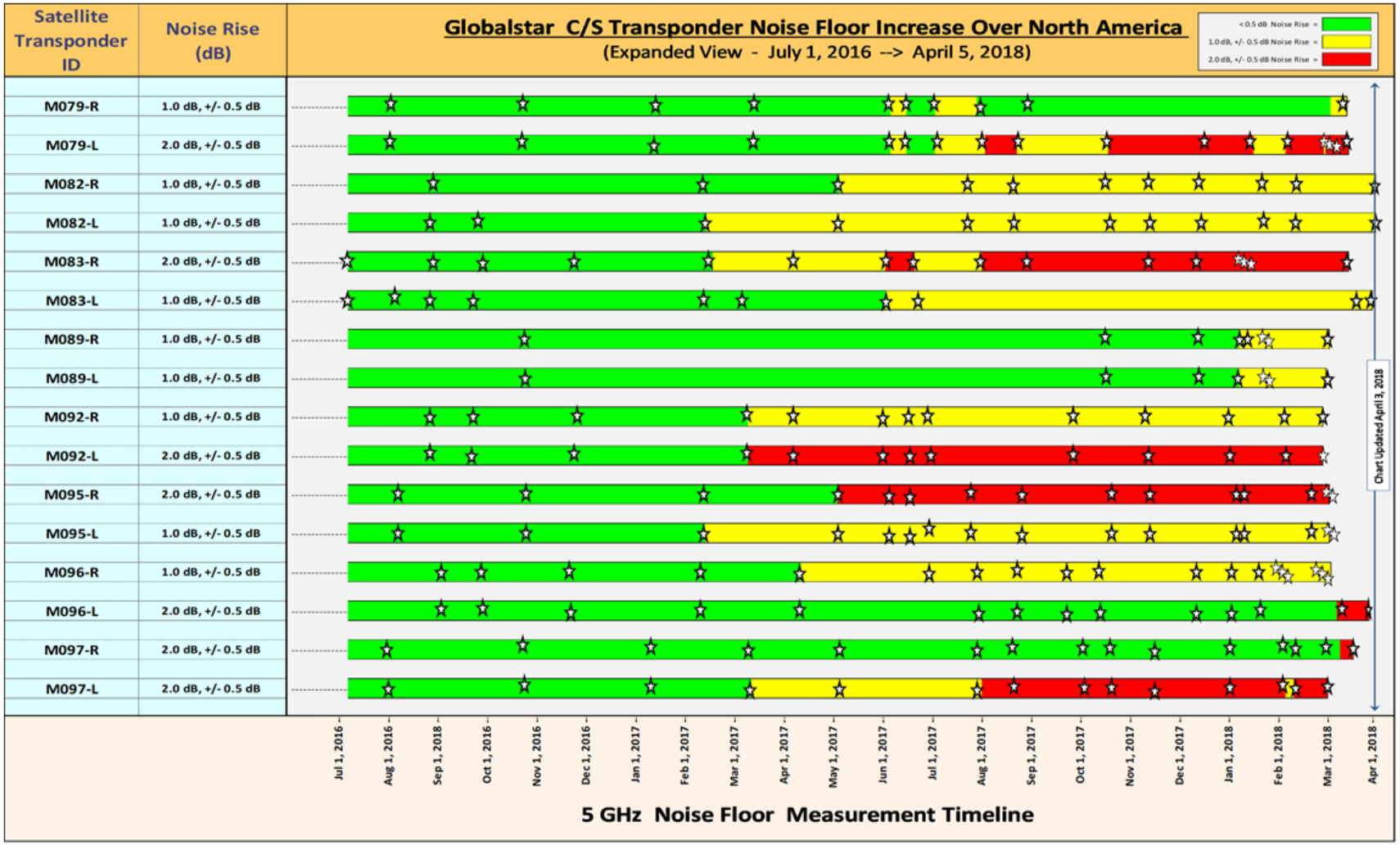
its measurement periods to two minutes. As indicated previously, Globalstar briefly suppresses communications traffic through its gateway earth station operations in North America in order to allow its satellites to measure the noise level, resulting in a service outage period. Globalstar must balance the need for sufficient noise floor measurements with its interest in avoiding undesirable disruption of its MSS offerings, which includes life-critical communication services. NCTA's request would require a service outage period of at least 35 minutes, which is no more acceptable than a scenario in which all cable operators' outdoor U-NII-1 access points are turned off for an extended period while Globalstar performs additional measurements to assess the impact on the noise floor.

14 Roberson Exhibit at 7-8.

15 *Id.* at 7.



5 GHz C/S Noise Floor Summary Timeline (With Approximate Measurement Dates)

operations are either not permitted or do not occur). Moreover, Roberson has shown that Globalstar's observed noise floor rise is consistent with a realistic estimate of the number of access points deployed for outdoor use and a realistic range of operating characteristics for those access points.[16] Significantly, it is not just a continuing increase in the *quantity* of outdoor access points that might have caused this noise floor increase over the past eighteen months. Duty cycles of existing access points can also increase over time as customers utilize those facilities more intensively, elevating the radiofrequency ("RF") energy transmitted into space and raising the 5.1 GHz noise level.[17] Opponents again have offered no contradictory data. Nor have the opponents posited a plausible alternative explanation.

In fact, *all available evidence points to uncontrolled, unlimited U-NII-1 access point operations following the 2014 5 GHz Order as the cause of the noise floor rise at 5096-5250 MHz*. NCTA itself has indicated that more than half of cable operators' 19 million access points operate in the U-NII-1 band.[18]

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[16] *See* Roberson Exhibit at 12. In stating that "deployment data from NCTA's members and other industry data suggests that [the] number [of outdoor deployments] is approximately 1%," NCTA artificially and inappropriately restricts the definition of an "outdoor" U-NII-1 access point. NCTA Opposition at 3. The category of "outdoor" U-NII access points should include any access point, regardless of where it is deployed, with an antenna pattern and signal propagation intended to permit coverage to areas and persons located outdoors. For instance, a U-NII-1 access point that is installed indoors, such as in a campus cafeteria, but is intended to provide service through a glass wall onto a terrace or courtyard, should be considered an outdoor device.

[17] Roberson Exhibit at 8.

[18] *See* Comments of NCTA – The Internet & Television Association, GN Docket No. 17-183, at 5-6 (Oct. 2, 2017). While NCTA claims that only a small percentage of these access points were deployed outdoors, its basis for that assertion is unspecified "informal" data. NCTA also relies on an attempt to predict the number of U-NII-1 devices deployed outdoors by considering data on whether the devices sold were marketed as indoor or outdoor devices. *See* NCTA Opposition at 11. But that provides no evidence as to how devices have actually been deployed – *i.e.*, whether indoor devices have been used to provide service outdoors.

Opponents' fail in their attempts to poke holes in this analysis. Some opponents question why Globalstar's measured noise rise began in February 2017, almost three years after the *2014 5 GHz Order*.[19] This time frame, however, likely tracks the large-scale activation of outdoor U-NII-1 Wi-Fi access points in the United States.[20] Following the 2014 order, it no doubt took some number of months for equipment (both access points and client devices) to be modified and certified for outdoor U-NII-1 operations in compliance with the Commission's rules. Additional time was likely required for operators to deploy and activate equipment in sufficient numbers and for usage to increase.[21] These outdoor U-NII-1 access points were likely deployed and activated in groups at irregular intervals, rather than in a linear fashion. In some areas, outdoor access points might have been deployed gradually but activated collectively over a short time period. In all events, to the extent that the Commission needs additional data on the relationship between Globalstar's measured noise rise and operators' deployment timelines, it should request in its NOI that parties provide relevant information on these factors.

Opponents also speculate, without supporting evidence, that the interference could be coming from other countries. Globalstar's measurements show the opposite. Globalstar has found no noise floor rise when its satellites are in view of Mexico, Central America, and the northern portion of South America, but not the United States. While Globalstar is unable to

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19 *See, e.g.,* NCTA Opposition at 2.

20 *See* Roberson Exhibit at 8, 9-10.

21 Three operators notified the Commission of substantial outdoor access point deployments during 2015, and one did so in 2017. *See* Letter from David Don, Comcast Corporation, to OET, FCC (Jan. 15, 2015); Letter from Peter Corea, Cablevision Systems Corporation (now Altice USA), to OET, FCC (2015); Letter from Greg Hansen, Vivint, Inc., to OET, FCC (Sept. 18, 2015); Letter from Damon Estep, Rise Broadband, to OET, FCC (Sept. 28, 2017), https://www.fcc.gov/engineering-technology/policy-and-rules-division/general/u-nii-1-band-515-525-ghz-operator-filing.

isolate and take measurements of Canada due to the inclination of its orbital planes, there is no basis to believe that the interference is due to Canadian operations. Unlike the Commission in the United States, Innovation, Science, and Economic Development Canada adopted a strict licensing regime for outdoor, higher power U-NII-1 deployments in 2017, and the few licenses granted so far under that framework do not transmit a significant amount of additional noise into the 5.1 GHz band, though this may change in the future with substantial additional deployments.[22] The few licensed Canadian devices are far outnumbered by the hundreds of thousands, if not millions, of unlicensed outdoor U-NII-1 transmitters deployed in the United States.[23]

Most notably, *opponents fail to identify any other plausible cause of this noise rise*. In contrast, Roberson has systematically assessed other potential causes of the noise rise and has systematically ruled them out. With respect to other RF operations at or near 5.1 GHz, for instance, Roberson found that neither Aeronautical Airport Communications System ("AeroMACS") facilities nor federal government Unmanned Aircraft Systems ("UAS") could have contributed materially to the noise rise, given that AeroMACS systems are operational only at two U.S. airports and UAS consists only of limited test operations below 5091 MHz (outside of Globalstar's feeder uplink spectrum).[24] Roberson also ruled out internal system issues as a

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[22] *See Decision on the Technical and Policy Framework for Radio Local Area Network Devices Operating in the 5150-5250 MHz Frequency Band*, Innovation, Science and Economic Development Canada, SMSE-013-17 (May 2017), https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/SMSE-013-17-decision-5150-eng.pdf/$file/SMSE-013-17-decision-5150-eng.pdf.

[23] Globalstar has conducted initial drive tests that demonstrate the abundance of Wi-Fi emission sources at 5.1 GHz and the low level of emissions in adjacent spectrum. Roberson and Associates, LLC, *Analysis and Impact of Noise Rise in Feeder Uplinks of Globalstar Mobile Satellite Network*, attached as Exhibit B to Petition, at 14, 75 (May 21, 2018) ("May 21 Roberson Analysis").

[24] Petition at 12 n.35; May 21 Roberson Analysis at 49. Cisco grasps at straws with its mention of aeronautical telemetry systems, Federal Aviation Administration point-to-point services, and government radar operations within or near the 5091-5250 MHz band. It presents

potential cause of the noise rise, because Globalstar's regular testing has shown that the performance of on-board satellite components has not changed since launch.[25]

C. Absent Commission Intervention, the Noise Floor Rise at 5.1 GHz Will Continue Indefinitely and Could Reach Extreme Levels in the Near Future

Contrary to opponents' claims, Roberson's projections regarding the future noise floor rise at 5.1 GHz are sound. Without Commission intervention, this noise rise will continue unabated and could reach extreme levels in the near future. Roberson predicts that, by 2022, the noise floor at 5170-5250 MHz (where U-NII-1 systems operate) will rise by between 4.7 dB and 8.2 dB, compared to the May 2014 noise level.[26]

The increasing quantity of outdoor U-NII-1 access points will be a key factor in the noise floor rise, and opponents' filings confirm that there will be substantial additional deployments of these Wi-Fi devices. Indeed, NCTA, the Wi-Fi Alliance, Cisco, and WISPA all emphasize the industry's plans to deploy outdoor U-NII-1 Wi-Fi operations.[27] The Commission can thus expect a variety of unlicensed operators to use this band more intensively over time.

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no evidence whatsoever that such systems are either causing or could cause the noise floor rise at 5.1 GHz. *See* Cisco Opposition at 7-8 n.14. Roberson fully considered such RF sources and concluded that they were not material contributors to the noise floor rise. May 21 Roberson Analysis at 52-53.

[25] May 21 Roberson Analysis at 40.

[26] May 21 Roberson Analysis at 31-32, 54. A noise rise between 4.7 dB and 8.2 dB at 5170-5250 MHz produces a noise rise of between 3.0 dB and 5.9 dB across Globalstar's feeder uplink spectrum at 5096-5250 MHz. *See* Petition at 14 n.39.

[27] NCTA Opposition at 17-18; Opposition of Wi-Fi Alliance at 2 ("Wi-Fi Alliance Opposition"); Cisco Opposition at 2; Comments of the Wireless Internet Service Providers Association at 2 ("WISPA Comments").

NCTA previously indicated that over 50% of cable operators' access points have been deployed in the U-NII-1 band,[28] and this reliance on U-NII-1 will likely extend to future deployments. NCTA states in its Opposition that a new Wi-Fi standard, IEEE 802.11ax, will rely on very wide channel bandwidths of 80 MHz and 160 MHz to enable more robust video streaming and other high-bandwidth applications, meaning that there will inevitably be heavier use of the U-NII-1 band and other unlicensed spectrum at 5 GHz in the coming years.[29] For its part, the Wi-Fi Alliance indicates that "initial implementation [at U-NII-1] is still underway," implying that there will be more intensive use of the U-NII-1 band in the future.[30] As it makes clear, unlicensed operators will continue to deploy outdoor U-NII-1 access points in a variety of commercial, industrial, and educational settings.[31] As discussed in the Petition, there may also be deployments of LTE-U/LAA base station transmitters, which could result in an even higher noise floor rise.[32] Overall, given that there is currently no U.S. regulatory limit on the number of outdoor U-NII-1 access point devices, an uncontrolled proliferation could result in the operation of tens of millions of unlicensed U-NII-1 transmitters in the United States.

Opponents' criticisms of Roberson's noise rise predictions are based on mischaracterizations and misinterpretations of Roberson's analysis.[33] Contrary to their claims, Roberson's projections assume a range of reasonable, realistic outdoor access point populations, duty cycles, and other parameters. Its calculations are based on access point populations ranging

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28 Presentation attached to Letter from Paul Margie, NCTA – The Internet and Television Association, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 13-49, at 2 (Oct. 12, 2016).

29 NCTA Opposition at 17.

30 Wi-Fi Alliance Opposition at 3.

31 *Id*. at 7.

32 Petition at 14-15.

33 *See* Roberson Exhibit at 10.

from 250,000 to a million and average duty cycles ranging from 10% to 40%.[34] In addition, Roberson's analysis of omnidirectional access points fully accounted for the effects of shadowing and clutter, contrary to NCTA's assertion.[35]

Notably, NCTA in 2014 predicted that outdoor U-NII-1 access points would *at most* cause a 1 dB noise floor increase.[36] Just a couple of years into meaningful outdoor U-NII-1 deployment, the noise rise at 5.1 GHz has already exceeded that level.[37] As Sirius XM Radio states in its comments, "the Commission should evaluate interference predictions from proponents of new unlicensed devices with extreme skepticism."[38]

D. The Noise Floor Rise in Globalstar's Feeder Uplink Spectrum Will Have a Severe Detrimental Impact on Globalstar's MSS Network and Its Customers

Roberson' analysis demonstrates that unlimited U-NII-1 deployments will ultimately occupy an unacceptable percentage of Globalstar's MSS capacity. With a noise floor rise at

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[34] May 21 Roberson Analysis at 2, 28-29. By comparison, NCTA's technical analysis in 2014 similarly assumed one to three million access points deployed in the United States and an average duty cycle of 40%. *See* Rob Alderfer, CableLabs, Dirk Grunwald and Kenneth Baker, University of Colorado, *5 GHz UNII-1: Wi-Fi and Globalstar Sharing Analysis*, attached to Letter from Rick Chessen, NCTA, to Julius Knapp, FCC, ET Docket No. 13-49 (Jan. 22, 2014).

[35] *See* NCTA Opposition at 12-13. Roberson did not include the effects of shadowing and clutter in its aggregate interference analysis for point-to-point access point facilities.

[36] Letter from Rick Chessen, National Cable & Telecommunications Association, to Julius Knapp, Chief, OET, FCC, ET Docket No. 13-49, at 10 (Jan. 22, 2014).

[37] As indicated in the Petition, Globalstar successfully shared its licensed feeder link spectrum at 5.1 GHz with unlicensed interests following the Commission's 1997 order permitting indoor U-NII-1 operations. *Amendment of the Commission's Rules to Provide for Operation of Unlicensed NII Devices in the 5 GHz Frequency Range*, Report and Order, 12 FCC Rcd 1576 (1997) ("*1997 U-NII Order*"). Prior to the *2014 5 GHz Order*, there was a fair balance in this spectrum between protecting Globalstar's MSS operations and promoting the development of unlicensed services. The Commission radically altered this balance in 2014, however, based in part on the representations and the predictive judgement of NCTA and the cable industry. The RF environment at 5.1 GHz has not evolved as NCTA claimed, however, creating the need for Commission investigation through the NOI process.

[38] Sirius XM Radio Comments at 3.

5170-5250 MHz between 4.7 dB and 8.2 dB by 2022, Roberson projects that Globalstar's satellite downlink CDMA capacity in affected areas will be reduced by *13% to 35%*.[39] This impact will be felt over an area equivalent to greater than 95% of the contiguous United States.[40]

The effects of this capacity reduction will be evident during hurricanes and other natural disaster scenarios, when terrestrial networks are often unavailable, safety-of-life satellite services are in heavy demand, and Globalstar experiences peak traffic levels. Given the projected noise floor rise, Globalstar's MSS network may not be able to support all users during and after future disasters. In situations where communications are most critical, many users will likely suffer significantly degraded service, including dropped calls, geographic coverage holes, failed call attempts, and impaired data transmissions.[41] As the National Public Safety Telecommunications Council ("NPSTC"), GEOS Response, LLC ("GEOS"), and other commenters highlight, Globalstar's MSS constellation supports services that are crucial for mission-critical and safety-of-life communications in such disaster scenarios.[42] If Globalstar is unable to provide its

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[39] May 21 Roberson Analysis at 38-39; Roberson Exhibit at 12. The current 2 dB noise floor rise at 5096-5250 MHz – equivalent to a 3.3 dB noise rise at 5170-5250 MHz – is already enough to affect Globalstar's MSS operations. While Globalstar's MSS network compensates for this noise rise through closed loop power control for a small number of uses in the affected spot beams, this compensation is at the expense of increased power consumption at the satellite.

[40] Contrary to opponents' claims, Roberson's analysis of the harmful impact on Globalstar MSS accounts for "spectral overlap." Roberson has indicated that the capacity impact and other degradation to Globalstar MSS occurs in the specific, large geographic areas that correspond to particular downlink "spot beams." May 21 Roberson Analysis at 10-12.

[41] Petition at 17; Roberson Exhibit at 12-13.

[42] *See* NPSTC Comments at 5 ("Globalstar service is used in both urban and wildland environments by first responders and that significant interference to that service could be detrimental to public safety."); Comments of GEOS Response at 1 ("For over ten years, [GEOS has] worked closely with Globalstar to ensure the safety and security of their customers worldwide"; "our combined efforts have resulted in nearly 6,000 life-saving rescues globally, with over 4,000 of those rescues occurring in the U.S. or Canada."); Comments of Mitigation and Resilience Strategies (MRS), LLC at 2 ("No other communication platform can offer and

resilient life-critical services during and after disasters, the result will be contrary to public safety and the public interest.[43]

Globalstar currently has over 700,000 subscribers globally, with most located in North America. Globalstar expanded its commercial simplex and SPOT business significantly while it was in the process of launching a new constellation of satellites. Globalstar completed that launch campaign in 2014, just as the Commission dramatically increased unlicensed use of the 5.1 GHz band. Since completing those launches, Globalstar has continued to invest in ground infrastructure upgrades to capitalize on its restored duplex capability, and it has recently introduced a new generation of duplex products to the commercial and consumer marketplace. Globalstar expects its existing and expanding customer base to migrate to its new duplex offerings, given their substantial increased functionality and favorable pricing. With over 1.3 billion SPOT and simplex messages processed last year, Globalstar expects substantial growth in the number of messages that will now be delivered to Globalstar's customers via its "forward link,"[44] greatly increasing the load on Globalstar's satellites.

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deliver dependability and security at the level of Globalstar, and in times of crisis, it is crucial to maintaining connections, especially in the world of first response.").

[43] As described in the Petition, Globalstar's MSS network provides critical back-up capabilities for public safety personnel during disasters, when terrestrial networks can be rendered inoperable. Public safety entities involved in relief efforts in North America and around the world have relied on Globalstar's satellite services after earthquakes, hurricanes, and other disasters. Petition at 4.

[44] Globalstar's forward link consists of its feeder uplink at 5.1 GHz (gateway to satellite) and its service downlink at 2.4 GHz (satellite to mobile terminal). SPOT-X forward link transmissions will be affected by the noise floor rise in Globalstar's feeder uplink spectrum.

Given the noise floor rise at 5.1 GHz and the threat of near-term harm, it is hardly premature for the Commission to issue an NOI and investigate conditions in the U-NII-1 band.[45] As it has done previously, the Commission can use the NOI process to obtain a detailed factual record for specific rulemaking proposals in a future Notice of Proposed Rulemaking.[46]

Indeed, the Commission should issue this NOI expeditiously rather than wait for evidence of an even higher noise floor rise. The Commission should act while the flood waters at 5.1 GHz are only at knee level and rising, when decisive action can still prevent serious harm. If the Commission waits until the noise rise becomes more pronounced, it will be too late. By that time, aggregate interference will disrupt Globalstar's licensed MSS operations and endanger the lives of its subscribers and other U.S. citizens.[47]

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[45] Contrary to opponents' claims, it would not have made sense for Globalstar to file a complaint against one or more of the unlicensed operators using the U-NII-1 band for outdoor operations. As an initial matter, while four companies have notified the Commission that they have deployed more than one thousand outdoor U-NII-1 access points, there is strong reason to believe that other operators have made such deployments without complying with that requirement, based on available equipment authorization data. *See supra* at 7 n.16; Petition at 23. Moreover, this aggregate interference problem is more fundamental than specific operators' activities or particular equipment compliance issues. As Roberson's technical analysis demonstrates, even if all service providers and devices at U-NII-1 were operating in full compliance with the Commission's Part 15 rules, the noise floor rise at 5.1 GHz and the harmful effects on Globalstar's MSS network and customers would still occur.

[46] *See* note 7 *supra*.

[47] Comments of One Solution Position at 1 ("Waiting until Globalstar and its customers suffer potentially life-threatening service disruptions is not a viable option.").

E. By Investigating the Noise Floor Rise and the Threat of Harm to Globalstar and Its Customers, the Commission Can Enhance U.S. Credibility on These Issues at the ITU

Several commenters argue that issuing an NOI would undermine a submission to ITU-R Working Party 5A ("WPA5 Submission"), which NCTA has attached to its comments.[48] This would not be the case. Unlike Roberson's analysis, the WPA5 Submission is not based on real-world interference measurements. Rather, the WPA5 Submission is a simulation that attempts to predict what the noise floor rise at 5.1 GHz will be, based on various assumptions about the volume and operating characteristics of U-NII-1 deployments. This simulation was developed by the very same industry participants that oppose the issuance of an NOI here. The assumptions that form the basis of the simulation are unfounded, as demonstrated by Roberson. For example, the WP5A Submission assumes unrealistically that only 6% of outdoor access points will operate at the maximum allowable level of 4 W EIRP,[49] and even assumes an average weighted outdoor power level (23.1 dBm) that is significantly lower than the average access point power for indoor devices (27.3 dBm).[50] The document also mistakenly assumes, among other things, that the noise rise at 5.1 GHz will only occur in the United States, that this interference will affect only one satellite at a time, that only half of Globalstar's CDMA channels at 5.1 GHz will be affected by the noise rise, that signal polarization will reduce the level of this interference, and that the

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48 *Working Document Towards a Preliminary Draft New Report ITU-R M.[RLAN REQ-PAR]*, United States of America Contribution, Doc. No. 5A/722-E (May 8, 2018).

49 Roberson Exhibit at 14.

50 *Id*.

degradation to Globalstar MSS should be discounted by the fraction of its satellite's global orbit that is spent over the United States.[51]

Indeed, the discrepancy between Globalstar's real-world interference data and the predictions made in the WPA5 Submission (based on faulty assumptions) provide an additional reason to issue the NOI. Creating a full record on the issue and investigating this discrepancy would improve the Commission's understanding of these issues and enable the U.S. delegation to withdraw its existing simulation or substantially revise it to provide a more accurate contribution, as appropriate. That would demonstrate the United States' commitment to sound science in administering spectrum, thus enhancing the United States' credibility before the ITU. By contrast, ignoring real-world interference data would give the impression the United States merely seeks to advance a specific agenda regardless of contrary evidence.[52]

F. The Commission's NOI Should Encompass the Deployment of Outdoor Fixed Point-to-Point and Point-to-Multipoint Systems in the 5.1 GHz Band

In its comments, WISPA asks that the Commission exclude consideration of wireless internet service providers' ("WISPs") fixed point-to-point access points from any NOI process.[53] While Roberson previously stated that point-to-point operations had not yet been a material

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[51] Roberson Exhibit at 15-17. The U.S. WP5A Submission attached by NCTA has faced significant criticism from multiple sector members within WP5A and, as such, is an evolving, red-lined document that shows edits made between November 2017 and May 2018. These changes include modifications to key assumptions and values. This document is likely to be edited further prior to the next meeting of the ITU Working Party 5A in November 2018.

[52] In the ITU-R Working Party 5A, the U.S. delegation is currently the only national administration that supports incorporating the main elements of the Commission's U-NII-1 framework into the ITU's Radio Regulations. Technical filings into the working group from Globalstar, France, Russia, China, and Japan all indicate that unlimited outdoor U-NII-1 operations will cause a substantial noise floor rise at 5 GHz and harmful aggregate interference to Globalstar's licensed MSS operations. Additional countries have expressed concern and skepticism regarding the U.S. simulation.

[53] WISPA Comments at 1.

cause of the 5.1 GHz noise floor rise,[54] it did not conclude that such systems will not be material contributors in the future. Given the rapid noise floor rise at 5.1 GHz during 2017-2018 and the serious harm that such aggregate interference will cause to Globalstar's licensed MSS operations, the Commission needs to closely examine *all* of the unlicensed terrestrial wireless systems operating in this spectrum.

Roberson indicates that the directional gain dish antennas typically utilized in outdoor point-to-point facilities will contribute more to the noise rise on a per-device basis than outdoor omnidirectional access points.[55] Given this per-device impact, the key determinant of their future aggregate interference effect will be the overall number of point-to-point facilities deployed in the United States. According to WISPA's comments, its members are likely to deploy a large number of such systems. WISPs currently use the U-NII-1 band extensively and will continue to do so.[56] Thus, in the requested NOI, the Commission should seek information on the current population of fixed outdoor point-to-point access points, the likely extent of future deployments, and other relevant data on point-to-point operations in the U-NII-1 band.

In its NOI, the Commission should also seek data about outdoor *point-to-multipoint* systems that utilize the kinds of directional beams used in point-to-point systems. RADWIN LTD. ("RADWIN") recently filed a petition for rulemaking asking the Commission to apply the power limits for point-to-point operations in the U-NII-1 band to point-to-multipoint systems featuring directional beams.[57] RADWIN's Petition says nothing about the impact of these point-to-multipoint systems on the 5.1 GHz noise or Globalstar's MSS operations. If the Commission

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54 May 21 Roberson Analysis at 52.

55 Roberson Exhibit at 18; *see also* May 21 Roberson Analysis at 18-19.

56 WISPA Comments at 2.

57 Petition for Rulemaking, RADWIN LTD., RM-11812 (June 18, 2018).

feels compelled to act on RADWIN's request, it should do so through its NOI and investigation of conditions at 5.1 GHz, rather than in a Notice of Proposed Rulemaking that proposes specific rule amendments.

III. Contrary to Opponents' Claims, an NOI Would Promote Regulatory Certainty

Opponents of the Petition allege that an NOI would create "regulatory uncertainty" for certain operators,[58] but that claim is incorrect. These parties have been on notice for more than four years – since the Commission's 2014 *5 GHz Order* – that the Commission would take action in response to harmful aggregate interference to Globalstar's MSS network. Indeed, under the Commission's notice requirement, any company deploying more than one thousand outdoor access points within the U-NII-1 band "must submit a letter to the Commission acknowledging that, should harmful interference to licensed services in this band occur, they will be required to take corrective action."[59] Thus, these operators have always known that they may need to modify their U-NII-1 operations if those operations begin to cause harmful interference.[60]

In fact, an NOI would *advance* regulatory certainty. A thorough Commission investigation would confirm the cause of the noise floor rise at 5.1 GHz and bring clarity to the sharing issues in this band. Inaction by the Commission, in contrast, will prolong the uncertainty associated with this interference threat. Unlicensed operators in the U-NII-1 band will not know whether their operations are causing harmful interference that could ultimately prompt

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58 *See* NCTA Opposition at 17-18; Wi-Fi Alliance Opposition at 8-9.

59 *2014 5 GHz Order* ¶ 38. The Commission indicated that such corrective actions "may include reducing power, turning off devices, changing frequency bands, and/or further reducing power in the vertical direction." *Id*.

60 Globalstar now faces substantial uncertainty regarding the future of its licensed MSS operations, due to the rising noise floor in its MSS feeder uplink spectrum. This uncertainty is heightened by the fact that Globalstar's opponents appear committed to more intensive use of the U-NII-1 band going forward (*see supra* at 11-12).

Commission enforcement activity and a total shutdown of outdoor U-NII-1 devices. That certain interests oppose even an investigation into the relevant facts suggests that those parties are concerned with the Commission's eventual findings, not "regulatory uncertainty."[61] In any event, the Commission cannot sit idly by and allow harmful interference to degrade licensed services in order to ensure "regulatory certainty" for operators causing that interference.[62]

While Globalstar appreciates that the opponents to the NOI believe in the importance of the services they provide (as Globalstar does with respect to its services), the Communications Act and the Commission's own rules require the Commission to protect licensed services against harmful interference from unlicensed operation.[63] Opponents to the Petition pay lip service to the Commission's obligation to protect licensed services from harmful interference, but they clearly place greater weight on their own commercial interests and their continued free, unfettered use of spectrum. These parties complain, for instance, that systems operating at U-NII-1 could be required to shift to other unlicensed bands and that this would result in system disruption and congestion in those bands.[64] Such concerns do not justify continued usage that causes harmful interference to a licensed service. In any event, these commercial interests will not be meaningfully compromised by a Commission inquiry designed to protect Globalstar's MSS network and its customers from harmful interference.

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61 Whatever alleged "regulatory uncertainty" results from the NOI process, such uncertainty appears far preferable to the disruptive effects of sudden, sweeping Commission enforcement action against unlicensed operators.

62 With their claimed need for regulatory certainty, opponents to the Petition in effect argue that the Commission should freeze its rules in place and never evaluate how those rules are working in the real world. Under this approach, the Commission would never innovate or take risks by enabling new uses of spectrum.

63 *See, e.g.*, 47 U.S.C. § 301; 47 C.F.R. § 15.5(b)-(c); *2014 5 GHz Order* ¶ 3.

64 *See, e.g.*, WISPA Comments at 5-6.

Finally, opponents of the Petition claim that an NOI would waste scarce administrative resources.[65] There is no better use of Commission resources, however, than to investigate and prevent harmful interference, a core Commission obligation under the Communications Act.[66]

IV. Conclusion

With its compelling showing in the Petition for Notice of Inquiry, Globalstar has clearly met the threshold for the Commission to issue a Notice of Inquiry. In its NOI, the Commission should investigate the ongoing 5.1 GHz noise floor rise, assess the potential harm to Globalstar MSS and its customers, and explore possible regulatory and market-based solutions to this growing threat of harmful aggregate interference.

Respectfully submitted,

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65 *See* Cisco Opposition at 2; NCTA Opposition at 18; Wi-Fi Alliance Opposition at 8-9.

66 *See, e.g.*, 47 U.S.C. § 301; 47 C.F.R. § 15.5(b)-(c); *2014 5 GHz Order* ¶ 3.

Exhibit A

Roberson and Associates, LLC
Technology and Management Consultants

Technical Analysis of Comments to Globalstar Petition

Prepared for Globalstar Inc., by:

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Date: July 23, 2018

Technical Analysis of Comments to Globalstar Petition

Summary

In 2014, the Federal Communications Commission (Commission) issued a Report and Order authorizing unrestricted numbers of unlicensed outdoor emitters in the U-NII-1 band at 4 Watts EIRP, for the first time allowing spectrum sharing between outdoor U-NII-1 systems and the licensed fixed feeder uplinks of Globalstar's mobile satellite service (MSS) network. In May 2018, Globalstar petitioned the FCC to issue a Notice of Inquiry (NOI) to investigate the feasibility of continued spectrum sharing between these systems, based on extensive satellite measurements indicating a rise in the noise floor in its feeder uplink spectrum and also based on the large and increasing number of access points deployed in U-NII-1. The observed noise rise exceeds 2014 forecasts of interference made by operators of networks utilizing unlicensed spectrum.

Commenters expressing opposition to Globalstar's Petition for a Notice of Inquiry have challenged the validity of the technical evidence that Globalstar has provided in support of the Petition. Roberson and Associates, LLC was requested by Globalstar to analyze the technical aspects of the challenges of the Commenters.

As an initial matter, the Roberson analysis summarized here finds that commenters opposing Globalstar's Petition for an NOI present no physical, empirical data of their own or technical analysis of Globalstar's satellite data demonstrating that the noise rise in Globalstar's feeder uplinks is not real. Similarly, commenters opposing an NOI present no evidence that the noise rise does not originate in the U-NII-1 band. In fact, commenters' forecasts for intensified utilization of U-NII-1 by unlicensed operations support the conclusion that the threat of harmful interference to Globalstar is real.

Questions raised by opponents to the Petition regarding the validity of the noise rise measurements can be readily answered. On questions regarding the length of Globalstar's measurements, its two-minute measurement period in fact has resulted in valid, representative data. Globalstar conducts these measurements on each of eight satellites over the United States approximately twice a month and has accumulated more than 500 two-minute measurements overall. Globalstar continues to conduct these measurements and augment this data. During a two-minute period, Globalstar's satellites traverse over 430 miles of the earth's surface, and the orbits of successive satellites as they traverse the United States do not trace exactly the same path. The large number of measurements acquired over a period of more than four years, coupled with the consistency of the measurements since an increase in the noise floor has been detected, provide ample evidence concerning the validity of the measurements.

NCTA – The Internet & Television Association (NCTA) has submitted an ITU-R contribution containing an interference model – relying on assumptions not based on actual US access point operational data – that concludes that the maximum interference level experienced by Globalstar's satellites should be 10 times lower than that forecast by the 2014 analysis. The Wi-Fi Alliance, however, observes that "initial implementation [of unlicensed operations in U-NII-1] is still

underway," and further states that "by 2021, global mobile traffic is expected to grow…by a seven-fold increase over 2016."

If operations in U-NII-1 are only in the initial stages and outdoor device operations in U-NII-1 grow at this stated rate, Globalstar's satellites will measure a noise rise of 4 dB or more in three years, causing capacity reductions in the number of simultaneous mobile satellite users as great as 20% in more than half of the service area of Globalstar satellites as they traverse the US. This degradation for each satellite is in an area equivalent to more than 95% of the area of the contiguous US and is for the duration of the busy period of unlicensed operations. This degradation will result in increased dropped calls and failed call attempts for users of Globalstar's MSS network. These degradations will be suffered by all users, including first responders and emergency callers that rely on Globalstar services during large scale disaster situations such as hurricanes. It is at these times that the number of simultaneous users of Globalstar's satellites is at its peak.

The only conclusion that can be drawn by Globalstar based on its own measurements and opponents' projections of future U-NII-1 use is that the noise rise that its satellites are experiencing now will increase in the near future to a clearly harmful level.

Table of Contents

1. Introduction

Commenters expressing opposition to Globalstar's Petition for a Notice of Inquiry have challenged the validity of the technical evidence that Globalstar has provided in support of this Petition. This report contains our responses to and technical analyses of those challenges.

Organization of Technical Analysis

The technical arguments against the Petition can be organized into several categories, as follows:

1) Globalstar's noise rise measurements are not valid;

2) Roberson and Associates' analysis and conclusions regarding the likely causes of the noise rise and resulting degradation to Globalstar's network and users are not valid;

3) Globalstar has not demonstrated that a noise floor rise will cause harmful interference to its MSS operations;

4) The interference model in the US Contribution to ITU-R WP5A indicates that there will be no meaningful noise floor rise in Globalstar's feeder uplink spectrum or harmful interference to Globalstar's MSS operations (in contradiction to the physical evidence of the noise rise measured by Globalstar and the analysis of Roberson);

5) Consideration of WISP point-to-point operations should not be incorporated into an NOI.

In the sections of this report below, we address each of these arguments and show that they do not have merit.

2. Analysis of Challenges to Validity of the Noise Rise Measurements

2.1 Accuracy, Calibration, and Methodology of the Noise Rise Measurements

Opponents to the Petition raise arguments regarding the validity of Globalstar's noise floor measurements. We address them as follows:

Globalstar's methodology can only be regarded as robust, providing convincing evidence that the noise rise has occurred. Globalstar's measurement report[1] describes more than four years of measurements. It also details a rigorous and extensive calibration procedure performed in-orbit

[1] Globalstar, Inc. Petition for Notice of Inquiry Regarding the Operation of Outdoor U-NII-1 Devices in the 5 GHz Band, RM-11808, Appendix A, Globalstar 5 GHz Noise Floor Measurement Description and Current Results. (filed May 21, 2018) (Globalstar Measurement Report).

for each of the 2 transponders on 8 separate satellites, one in each orbital plane—a total of 16 separate calibration runs. Measurement of the noise floor in increments of 1 dB with an uncertainty of +/- 0.5 dB, along with the large number and consistency of the measurements, are sufficient to provide confidence in the noise rise levels observed.

Opponents to the Petition provide no technical analysis of the noise rise measurement data filed by Globalstar, nor any noise measurement data of their own, that contradicts the existence of the noise rise. The noise rise data submitted as supporting evidence to the Petition by Globalstar was known to the NCTA for over six months, as Globalstar made the measurements public in November 2017[2] and again in May 2018[3] as contributions to ITU-R WP5A.

Noise rise measurements performed just after the 2014 Report and Order are highly relevant, since they establish one of the control conditions for validating the existence of a noise rise. In fact, there are two sets of "control" conditions for confirming the existence of the noise rise over the US. The first set of control conditions is the baseline noise floor measurements performed in 2014 for the 8 satellites while they were in orbit, but before and just after the issuance of the Report and Order. The second set of control conditions is the noise floor measurements made on the 8 satellites as they travel over the non-US regions of the earth where outdoor unlicensed operations are not permitted.

Significantly the noise floor measured did not change from the 2014 baseline until February 2017 when a noise rise was first observed over the US. Nor has a noise rise compared to the 2014 baseline been observed for satellites outside US, including satellites over Europe, Australia, South America, and "blue ocean."

Regarding the need for more measurements, 484 two-minute noise rise measurements over the United States prior to the filing of the Petition were made for 8 satellites. As the Measurement Report also describes, each two-minute measurement interval consists of between 8 and 16 individual noise rise measurement samples. This large dataset is more than sufficient to confirm that the noise rise is real. Additional measurements are continually being made and continue to confirm the noise rise increase. The number of measurements made as of the filing of the Globalstar's Reply Comments is summarized in the Table below.

[2] Proposed Revision of the Working Document Towards a Preliminary Draft New Report ITU-R M.[Aggregate RLAN Measurements] Aggregate RLAN measurements from airborne and terrestrial platforms to support studies under WRC-19 agenda item 1.16, Globalstar Contribution, Doc 5A/554-E. (Nov 1, 2017). (2017 Globalstar Measurements Contribution).

[3] Proposed Revision of the Working Document Towards a Preliminary Draft New Report ITU-R M.[Aggregate RLAN Measurements] Aggregate RLAN measurements from airborne and terrestrial platforms to support studies under WRC-19 agenda item 1.16, Globalstar Contribution, Doc 5A/758-E. (May 15, 2018) (2018 Globalstar Measurements Contribution).

Measurements Performance Before Petition Filed 21-May-2018	484
Measurements Performed After Petition Filed	36
Total Measurements Through 20-July-2018	520

Table: Globalstar Noise Rise Measurements

Regarding the challenge that the noise rise measurements are made only at a single time and single location, Globalstar measurements are made in a time window between 9 AM and 6 PM, not just at a single time. This time window corresponds to the time that Cisco states is the peak period for unlicensed operations. Similarly, although measurements are centered over Lincoln, Kansas, the Measurement Report states that they are actually made while the satellite is within a relatively large geographic area, rather than at one precise location; the Measurement Report states that the sub-satellite point is located within a circle of about 308 miles radius centered on Lincoln Kansas. This location was chosen as the location with the representative level of interference that would be experienced. Modeling[4] shows that while the interference level peaks at approximately this location, the peak is broad and the noise rise stays at an elevated level as the satellites traverse the US.

Regarding the necessity for a measurement interval longer than 2-minutes and the necessity for more measurements, the frequency and duration of measurements is limited by the service disruption to users caused by the measurement method. In order to perform a noise rise measurement a service outage must be scheduled. The number of measurements and their duration is then a balance between undesirable disruption of mobile satellite service to paying subscribers and the desire to obtain sufficient noise floor measurements. Any degree of service outage greater than two minutes in duration (the length of a typical phone call) a few times a month is unacceptable and unreasonable for Globalstar subscribers to suffer. Globalstar provides life-critical communication services to its customers.

Contrary to assertions by the NCTA that its requests for more measurement conditions were not answered, Globalstar performed nighttime measurements over the US, and daytime measurements isolating Mexico and northern South America, in addition to the measurements being made over Australia and Europe.

2.2 Variation in the Noise Rise Measurements

Opponents to the Petition raise arguments regarding the variations in Globalstar's noise floor measurements. We address them as follows:

Noise measurements performed at different Globalstar satellites do not "differ widely." The variations in noise rise levels observed between the satellites are expected and can be explained at

[4] Globalstar ITU-R Contribution, Analysis of Sharing, Doc 5A/759, section 5.1.2.4.8, pages 17-18 (May 15, 2018) (2018 Globalstar Sharing Contribution).

least in part by the +/- 0.5 dB uncertainty in the noise rise measurements at each satellite, as determined by the extensive calibration procedure described in the Globalstar Measurements Report. This uncertainty range helps explain why six of eight satellites are measuring a 2 dB +/- 0.5 dB noise rise in at least one of their two transponders, while the other two satellites are only measuring a 1 dB +/- 0.5 dB noise rise.

There is a high confidence level that the noise floor rise measured by Globalstar is real. Globalstar's rigorous calibration procedure, the two types of "control" conditions described above, and the existence of more than 500 noise rise measurements collected over four years over the United States all provide convincing evidence that this noise rise has actually occurred and is continuing.

Regarding the noise rise from 1 to 2 dB in six months, opponents to the Petition argue that, to the extent that this noise rise can only be explained by an increase in the number of outdoor U-NII-1 access points, a 25% increase in the number of such access points over a six-month period is not realistic. Neither Globalstar nor the Roberson Analysis[5] asserts, however, that the increase in the noise rise is due solely to a 25% increase in the number of deployed access points over that time. The noise floor can rise due to several factors. First, the noise rise could result from an increase in the utilization level (transmitter on time) of existing access points as users discover and use them more intensively. For example, a 25% increase in the duty cycle, from 10% to 13%, would cause the same increase in noise rise as a 25% increase in the number of access points. Second, this noise rise could result from the activation of large groups of access points in a short period of time, after those facilities have been more gradually deployed. It is unlikely that access points would be deployed and activated in a linear fashion. Rather, such access points would likely be deployed and activated in groups, at irregular intervals, causing stepwise increases in the noise rise.

Thus, the fact that (i) each satellite measures the noise rise with an uncertainty of +/-0.5 dB and (ii) access point utilization (and the interference caused by those devices) does not necessarily increase in a gradual, linear fashion, likely explains the variation between satellite measurements and the apparent jump in noise rise from 1 to 2 dB in six months.

[5] Globalstar, Inc. Petition for Notice of Inquiry Regarding the Operation of Outdoor U-NII-1 Devices in the 5 GHz Band, RM-11808, Appendix B, Analysis and Impact of Noise Rise in Feeder Uplinks of Globalstar Mobile Satellite Network (filed May 21, 2018) (Roberson Analysis).

3. Analysis of Challenges that Noise Rise is Not the Result of Outdoor U-NII-1 Deployments

Opponents to the Petition raise arguments questioning whether the noise rise is the result of outdoor U-NII-1 deployments. We address them as follows:

There is compelling evidence that outdoor U-NII-1 operations, permitted by the Commission in April 2014, are the cause of the measured noise rise. Globalstar has monitored the RF environment in the U-NII-1 band using eight of its satellites for over four years. As shown in the Globalstar Measurement Report,[6] the changes in the RF environment that began to be detected in February 2017 – only over the US – cannot be dismissed. No analysis of the measurements or other physical evidence or factual information has been brought forward to disprove this noise floor rise. The only place on Earth where a noise rise trend is evident is over the US, and the US is the only region where unrestricted numbers of unlicensed outdoor devices in 5150-5250 MHz have been allowed.

In response to NCTA requests, measurements have now been made isolating Mexico and portions of northern South America, along with Europe and Australia. These measurements show no noise rise in those areas. The measurement dataset continues to be augmented.

Opponents do not refute other substantial evidence and analysis that Globalstar has provided to indicate that outdoor U-NII-1 devices are the most likely cause of the noise floor rise. First, NCTA has gone on record with the FCC that more than half of the more than 19 million access points that their members have deployed are operating in the U-NII-1 band.[7] Second, modeling demonstrates that the observed noise rise can be explained by reasonable numbers of active outdoor U-NII-1 access points and reasonable operating parameters for those access points Finally, research has failed to identify any other potential interference sources that would contribute interference at the level necessary to cause the noise rise observed, either in the U-NII-1 band or in other portions of the Globalstar feeder uplink (5096-5150 MHz).[8]

Regarding the timing of the measured noise rise, it is in fact reasonable and expected that this noise rise in Globalstar's feeder uplink spectrum would not begin immediately after the Commission's rule changes. It would have taken months or even years for equipment (both access points and client devices) to be modified and certified. It would take additional time for equipment to be deployed and activated in sufficient numbers, and for usage to ramp up. This timing is consistent

[6] Globalstar Measurement Report, section 4.3, page 21, and Figure on page A-3.
[7] FCC filing, "Comments of NCTA-The Internet & Television Association; in the Matter of Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz, October 2, 2017," states that 19.7 million total access points were deployed by NCTA members. The October 12, 2016 ex parte filing re ET Docket 13-49, by Harris, Wiltshire, and Grannis, LLP, counsel for NCTA, the Internet Television Association, states that in October 2016, NCTA members have deployed a total of approximately 16 million public cable Wi-Fi hotspots, with 54% of the access points deployed by NCTA members in the U.S. U-NII-1 band. This corresponds to 10 million access points in 5170-5250 MHz in June 2017.
[8] Roberson Analysis, section 8, pages 48-52.

with the Wi-Fi Alliance's statement in its opposition that, even today, operations in the U-NII-1 band are in an initial phase.

NCTA alleges that Roberson's conclusion that outdoor U-NII-1 operations are causing the noise floor rise, as well as the forecasted continued noise rise, are based on unrealistic assumptions about Wi-Fi deployment numbers and parameters. NCTA misreads or misinterprets the Roberson Analysis, however. Roberson's assumptions about access point deployment numbers and duty cycles are in fact realistic. Roberson's analysis simply calculates what the noise rise *would be* for a range of access point numbers and for a range of duty cycles, and shows that the current noise rise can be explained by certain combinations of access point numbers and their duty cycles. It is clearly stated that the measured noise rise could result from different, realistic combinations of number of access points (from 250k to 1 M) and duty cycles (from 10% to 40%). Similarly, the 2014 CableLabs Analysis assumed a 40% duty cycle and from 1M to 3 M outdoor APs.[9] The Roberson Analysis assumed a power level of 4W EIRP, the same as in the 2014 CableLabs Analysis and a level consistent with the rules adopted in the 2014 Report and Order.

In its opposition, NCTA points to "informal data" from its members regarding the number of deployed access points. Since cable operators' Wi-Fi deployments are typically managed and controlled centrally, those operators should be able to ascertain the number of outdoor and indoor access points and their operating parameters and usage statistics (including duty cycles). NCTA has not provided precise quantitative data regarding these deployments, however.

In addition, the Roberson Analysis does not disregard foliage and clutter in its propagation model. Roberson performed two separate analyses with different sets of U-NII-1 parameters. One analysis included point-to-point communications links. For those point-to-point links, antennas are located above the clutter and foliage to provide line-of-sight operation and modeled accordingly. Roberson's other analysis modeled only Wi-Fi access points. In that analysis, clutter/shadowing loss was applied for all outdoor U-NII-1 Wi-Fi access points.

Globalstar's 2013 interference analysis predicted,[10] and the 2018 Roberson Analysis confirms,[11] that noise rise levels significantly beyond 1 dB could occur if unrestricted unlicensed deployment numbers are allowed in U-NII-1. Globalstar's noise measurement program demonstrates that such a noise floor rise has now occurred. It is highly likely that outdoor U-NII-1 access points are the cause of this measured noise rise.

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[9] Dirk Grunwald and Kenneth Baker, University of Colorado, and Rob Alderfer, CableLabs, 5 GHz U-NII-1: Wi-Fi and Globalstar Sharing Analysis, (2014) (2014 CableLabs Analysis) (appended to Letter from Rick Chessen, Sr. VP Law and Regulatory Policy, NCTA to Julius Knapp, Chief of OET, FCC, ET Docket No. 12-49 (filed Jan. 22, 2014).

[10] *Impact of U-NII-1 Rule Changes on Globalstar Operations*, Roberson and Associates, LLC, Chicago, Illinois (Nov. 27, 2013), (2013 Roberson Analysis) attachment to Supplemental Comments of Globalstar, Inc., ET Docket No. 13-49 (Nov. 29, 2013).

[11] Roberson Analysis, section 9.1, pages 53-54.

4. The Noise Floor Rise in Globalstar's Feeder Uplink Spectrum Will Continue

In their oppositions, opponents to the Petition make numerous statements which confirm that operators will intensify their use of the U-NII-1 band and that the noise floor rise will continue. These statements are summarized below:

Wi-Fi Alliance[12]

- Operations in U-NII-1 are in the initial phases;
- Demand for Wi-Fi connectivity necessitates both indoor and outdoor operations - for example, in campus settings;
- Wi-Fi growth (including outdoor operations) will continue – it points to a Cisco study forecasting a 7-fold increase in unlicensed use from 2016-2021.

Cisco[13]

- An NOI will depress investment in Wi-Fi deployment (implying that there will be further deployment in the U-NII-1 band and other unlicensed bands)

Based on predicted increases in the quantity of deployed outdoor U-NII-1 access points and potential increases in average access point duty cycles, the Roberson Analysis projected that by 2022, the noise floor at 5.1 GHz will rise by between 4.7 dB and 8.2 dB at 5170-5250 MHz, compared to the May 2014 noise level. In their oppositions to Globalstar's Petition, unlicensed stakeholders in effect confirm that the noise floor rise in Globalstar's feeder uplink spectrum will continue in the future. The Wi-Fi Alliance Opposition, citing a Cisco study, states that "by 2021, global mobile traffic is expected to grow… by a seven- fold increase over 2016."[14] The Wi-Fi Alliance states further that outdoor U-NII-1 deployments will occur in commercial, industrial, and educational settings.[15] It also indicates that "initial implementation [in U-NII-1] is still underway," meaning that operators' use of the U-NII-1 band will intensify over time.[16] Similarly, Cisco in its Opposition asserts that an NOI will depress investment in the use of unlicensed bands, implying that, in the absence of FCC action, investment in the U-NII-1 bands and other unlicensed spectrum will accelerate.[17]

From these statements, the unambiguous conclusion is that unlicensed operations in U-NII-1 will intensify in the near future to levels not foreseen or predicted in 2014, accompanied by a corresponding increase in the noise floor and resulting harmful interference to Globalstar MSS. Absent FCC action, the noise floor in Globalstar's feeder uplink spectrum will increase to extreme

[12] Wi-Fi Alliance Opposition at 3, 5, 7.
[13] Cisco Opposition at 2.
[14] Wi-Fi Alliance Opposition at 5.
[15] Wi-Fi Alliance Opposition at 7.
[16] Wi-Fi Alliance at 3.
[17] Cisco Opposition at 2.

levels, beyond the level measured today, beyond the level forecast by unlicensed interests in 2014, and beyond the expectations on which the Report and Order was based.

Indeed, if outdoor device operations in U-NII-1 grow at the rate claimed by Cisco and the Wi-Fi Alliance Opposition, Globalstar's satellites will measure a noise rise of 4 dB or more in three years. This is consistent with the projected noise floor rise - also based on unlicensed stakeholder forecasts - contained in the Roberson Analysis.[18]

5. Analysis of Criticism that Harmful Interference is Unlikely to Occur

Opponents to the Petition raise arguments stating the harmful interference to Globalstar MSS is unlikely to occur. We address them as follows:

The Roberson Analysis[19] demonstrated that the noise floor rise in Globalstar's feeder uplink spectrum will result in an unacceptable reduction in Globalstar's MSS capacity. The Roberson Analysis indicated that with a noise floor rise between 4.7 dB and 8.2 dB at 5170-5250 MHz (where U-NII-1 Wi-Fi devices operate) by 2022, Globalstar's satellite downlink CDMA capacity in affected areas will be reduced by 13% to 35%.[20] This impact will be felt over an area equivalent to more than 95% of the size of the contiguous United States. The current 2 dB noise floor rise at 5096-5250 MHz – equivalent to a 3.3 dB noise rise at 5170-5250 MHz – is already sufficient to negatively impact Globalstar's MSS operations. While Globalstar's MSS network compensates for this noise rise through closed loop power control for a small numbers of users in the affected spot beams, this compensation is at the expense of increased power consumption at the satellite. Furthermore, the compensation cannot be maintained for large numbers of users.

If the noise rise increases from the current level to a level consistent with opponents' expectations for unlicensed growth in the U-NII-1 band (consistent with the Cisco study[21]), then Globalstar's satellite downlink CDMA capacity by 2021 will be reduced by at least 20% in more than half of the service area of Globalstar satellites in the United States and surrounding areas.[22] This capacity reduction will become much greater as the noise floor continues to rise after 2021.

The Roberson Analysis[23] does not overstate the impact of the noise floor rise and the resulting harmful interference to Globalstar MSS. As the Roberson Analysis indicates,[24] the capacity impact

[18] Roberson Analysis, section 5.3.3, pages 30-32, e.g., Figure 17
[19] Roberson Analysis, section 6.3.1, pages 36-39, e.g., Figure 19.
[20] Roberson Analysis, page 39, Figure 19.
[21] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016–2021, Document ID:1454457600805266, March 28, 2017, accessed at https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-indexvni/mobile-white-paper-c11-520862.html#AnalyzingtheExpandingRole.
[22] Roberson Analysis, page 11, Figure 4.
[23] Roberson Analysis, section 7, pages 46-47, Figures 23 and 24.
[24] Id. at Figure 4, p. 11.

and other degradation to Globalstar users occurs in the large geographic areas of specific downlink "spot beams" that correspond to the spectral regions of the Globalstar feeder uplink in which the U-NII-1 transmissions occur. For satellite users, this degradation will occur for multiple minutes, equaling or exceeding the length of average phone calls or data sessions. This degradation occurs continuously for users in the affected spot beams of successive satellites as they traverse the US during the U-NII-1 busy period. In addition, this degradation is experienced in approximately half of the geographic service area of the satellite. As shown in the Roberson report, this is an area equivalent to more than 95% of the area of the contiguous US.

In the US ITU-R Contribution to WP5A,[25] the US sharing analysis ignores the fact that the impact of an interference-induced capacity reduction is experienced by all users in the affected area – again, the portion of the service area of a satellite encompassing an area equivalent to more than 95% of the area of the US. As shown in the graphs in the Roberson Analysis, the reduction in the number of potential simultaneous users occurs only within the spot beams affected by the interference. The fact that the capacity reduction occurs only in half the spot beams, however, does not diminish the harm caused to the users within those spot beams. In a disaster situation, if the satellite's ability to serve a large number of users is degraded within a spot beam by U-NII-1 interference, the capacity degradation in that area is not mitigated by the fact that other spot beams are not affected. Degradation of Globalstar's service due to reduced subscriber capacity will occur during peak periods of MSS usage, such as after hurricanes and other disasters. This service degradation will cause the most harm just when users are in most critical need of Globalstar service.

While Globalstar's one-way, simplex services will not be affected by the satellite CDMA capacity reduction, Globalstar has recently introduced the two-way SPOT-X product. New SPOT-X subscriber and SPOT subscribers who migrate to the two-way SPOT-X will be affected by the capacity degradation in Globalstar's feeder uplink spectrum.

[25] Sharing and Compatibility Study Between WAS/RLAN Applications and NGSO Systems in the Mobile Satellite Service with FSS Feeder Links Operating in the 5091-5250 MHz Band, United States of America Contribution, Doc No. 5A/727-E. (May 9.2018) attached to NCTA Opposition as Appendix A. (US Sharing Study).

6. Analysis of the US Contribution to ITU-R WP5A that Concludes Globalstar is Unlikely to Experience Harmful Interference

Opponents to the Petition make arguments questioning the validity of Globalstar's noise rise measurements and the Roberson Analysis by referencing the US Contribution to ITU-R WP5A, which comes to opposite conclusions. We address the validity of the US Contribution as follows:

Serious Flaws and Errors in the US Sharing Study and Conclusions

Globalstar and Roberson and Associates are well aware of the US Contribution to ITU-R WP5A, having participated in this process and made their own submissions to the ITU-R. Scrutiny of the US Sharing Study in the US Contribution reveals serious flaws that render its conclusions suspect. It would be dangerous to rely on the US Sharing Study as an indicator that high-power, outdoor U-NII-1 operations will not cause harmful interference to Globalstar MSS. The primary flaws in the US Sharing Study include the following:

Flaw 1: Reliance on model input parameters that are not based on either the 2014 Report and Order or actual deployment information or unlicensed stakeholder forecasts of unlicensed use;

Flaw 2: Failure to consider Globalstar's actual noise rise measurements, made public in Globalstar's ITU-R WP5A contribution in November 2017 and updated in May 2018.

Flaw 3: Significant underestimation of the impact on Globalstar satellite operations and users, due to numerous errors and mistaken assumptions, including: 1) incorrectly discounting the degradation to Globalstar MSS by the amount of time the satellite is over the US, compared to the orbital period of the satellite; 2) incorrectly discounting the degradation caused by the noise rise in Globalstar's feeder uplink spectrum due to uplink channelization; 3) failing to account for the fact that if outdoor U-NII-1 operations are allowed worldwide, satellites will be impacted over all regions where outdoor access points are deployed; 4) incorrectly applying the ITU-R channelization factor, which is not applicable in the US; 5) neglecting the fact that, at any instant in time, multiple Globalstar satellites are impacted by the noise floor rise in Globalstar's feeder uplink spectrum over the US; 6) incorrectly applying a polarization discrimination factor in calculating the noise floor rise.

Flaw 1 - Further Discussion

The US Sharing Study model parameters are not reflective of US rules for U-NII-1 operations. The average EIRP for outdoor emitters applied in the US Sharing Study[26] is *less* than that allowed by US regulations by a factor of 20 (or 13 dB): 204 mW versus 4 W. In the US Sharing Study, only 6% of outdoor devices are assumed to operate at the allowed 4 W EIRP.[27] This average access point

[26] US Sharing Study, page 14, Table 3
[27] In the US Sharing Study, 6% of the outdoor access points constitute 0.012% of the total number of access points modeled, indoor and outdoor.

power for all outdoor devices (23.1 dBm) is *lower* than the average access point power for indoor devices (27.3 dBm). In fact, higher power levels are expected outdoors, since a longer communication distance is typically required compared to indoors. Higher gain antennas are also expected outdoors as compared to indoor environments. The outdoor/indoor ratio utilized in the US Sharing Study is also very different from ITU-R recommended parameters. The US Sharing Study uses a 98:2 indoor/outdoor ratio, while ITU-R uses a 94.7:5.3 ratio. Additionally, the US Sharing Study fails to take into account the existence of outdoor fixed point-to-point links in the US, where regulations for these systems permit a conducted power of 1 W and 23 dBi gain antenna, or an EIRP of 200 W.

Flaw 2 - Further Discussion

As a result of errors in the interference model parameters, the US Sharing Study concludes that a -9.4 dB interference to noise power ratio will be created in the Globalstar uplink spectrum impacted by Wi-Fi interference (5170-5250 MHz). In asserting this result, the US Sharing Study completely ignores and has given no explanation for the fact that this interference power is significantly less than the interference to noise ratio indicated by Globalstar's measurement data. Globalstar's contribution to ITR-R WP5A in November 2017, updated in May 2018, reveals a 2 dB noise rise in 5096-5250 MHz, which is indicative of a +0.6 interference to noise power ratio in 5170-5250 MHz,[28] a factor of ten higher interference power.

Flaw 3 - Further Discussion

1. Incorrectly discounting the degradation by the amount of time the satellite is over the US
2. Incorrectly discounting the degradation based on uplink channelization
3. Failing to account for the fact that if outdoor U-NII-1 operations are allowed worldwide, Globalstar satellites will be impacted over all regions where there are outdoor operations

The US Sharing Study significantly underestimates the impact of the interference that is experienced by satellite users. The study erroneously reasons that if an individual satellite only experiences interference over the US, then any degradation to Globalstar MSS – such as diminished capacity for simultaneous users – should be reduced by the fraction of time that the satellite is over the US compared to its total orbital period.

By assuming that interference would only happen to Globalstar while its satellites are over North America, the US Sharing Study ignores the WRC Agenda Item 1.16 proposed for study in the ITU-R. The subject of study is a proposed rule change to permit global unlicensed outdoor operation in the U-NII-1 band. If this agenda item is to be properly studied, then interference over the entire globe needs to be considered, not just over North America. Even if only the impact of emissions from within the US and its territories is considered, harmful interference to Globalstar MSS is certainly possible in Canada and Mexico, as well as in parts of South America, Europe, and Asia. A satellite over the Atlantic coast can re-transmit interference to parts of Europe, and a satellite over the Pacific can re-transmit interference to parts of Asia. Similarly, a satellite over the Caribbean can re-

[28] See 2018 Globalstar Measurements Contribution .

transmit interference to parts of South America. As result of this error, the US Sharing Study reduces interference to Globalstar MSS by a factor of 15/114, when this factor should be 1/1.[29] This is equivalent to a difference of 9 dB.

In reality, the degradation to mobile satellite users on the ground occurs continuously in the affected spot beams of successive satellites as those satellites traverse the US during the busy period of U-NII-1 activity. NCTA states that this busy period occurs between 10 AM and 9 PM.[30]

The U.S. Sharing Study also asserts that because interference only occurs in 53 out of 104 CDMA channels on the Globalstar uplink, any degradation can be diminished by a factor of 53/104.[31] This is not correct. The fact that the reduction in user capacity occurs only in the spot beams impacted by the U-NII-1 unlicensed interference does not, as the US Sharing Study alleges, diminish the degradation to the users within those spot beams. This degradation occurs for the entire duration of the busy period for unlicensed emitters in the U-NII-1 band as successive satellites pass over the US. For satellites traversing the US during this period, service degradation is experienced on the ground in approximately half of the geographic service area of the satellite, an area approximately equivalent to 95% of the area of the contiguous US, as shown in the Roberson Analysis. In a disaster situation, if the satellite's ability to serve a large number of users is degraded within a spot beam by U-NII-1 interference, the capacity degradation in that area is not mitigated by the fact that other spot beams are not affected.

In addition, two or sometimes three satellites can experience interference at the same time, and the impacted spot beams will overlap. In Globalstar's bent-pipe architecture, all of a satellite's spot beams are on the same RF frequency on the satellite-to-terminal link at 2.4 GHz.[32] For any mobile terminal on the ground, interference from any of two or three satellites in view will affect performance. As a result, the CDMA channels used by user terminals on the ground that might be unaffected by one satellite can still receive interference from another satellite. Since there are actually 208 CDMA channels per satellite - 104 in each polarization - the interference will be distributed across all the satellite channels (see the polarization factor discussion 6).[33] The US Sharing Study appears to use the orbital and channelization discounts to reduce the impact of the interference by 50%. Instead, the interference effects should increase by a factor of 1.8.

4. Incorrectly applying the ITU-R channelization factor.

The US Sharing Study calculates a bandwidth or channelization overlap factor that applies to the ITU-R WP5A agenda item 1.16, but not to the current FCC regulations. Specifically, Figure 7 of the US Sharing Study diagrams available Wi-Fi access point channels. In this figure, channels that are

[29] US Sharing Study, section 5.1.1.4.3, Step 6, page 35, Equation 9a
[30] NCTA Opposition, page 6.
[31] US Sharing Study, section 5.1.1.4.3, Step 7, page 35
[32] Roberson Analysis, section 2.2, page 8, Figure 1.
[33] Roberson Analysis, section 2.3, page 10, Figure 3. The figure shows 208 CDMA channels distributed in RHCP and LHCP polarization.

not used in the US are shaded dark blue and dark red.[34] The dark red channels are erroneously included in the calculation of the overlap factor to obtain a factor of 14.3% in Table 9.[35] If those dark red channels are instead excluded from this calculation consistent with current US regulations for outdoor operations, then the overlap factor increases to 18.3%. The effect of this increase in the overlap factor is to increase interference by 1 dB.

5. Neglecting that any instant in time, multiple Globalstar satellites are impacted

The US Sharing Study only calculates effects on a single satellite. The study assumes that only one satellite is affected at a time. However, as indicated above, a significant fraction of the time, two or three Globalstar satellites will simultaneously be in view of users located in North America. All of these satellites will be affected by noise generated by outdoor U-NII-1 transmissions. The effects of multiple satellites are diagrammed in the Roberson Analysis in Appendix C, Figure 29.[36]

6. Incorrectly applying a polarization discrimination factor

The US Sharing Study includes polarization discrimination (see section 5.1.1.3.2.4 and equation 3) that is not valid for Globalstar satellites.[37] The study assumes that outdoor U-NII-1 devices are linearly polarized, and then determines that interference incident at the satellite will be attenuated by 3 dB due to polarization mismatch with right-hand or left-hand circular polarization (respectively RHCP and LHCP).[38] A Globalstar satellite receives both polarizations, however, and any access point linear polarization will be a simple weighted sum combination of RHCP and LHCP waves.[39] In general, any linear, elliptical, or circular polarization will be decomposed to some combination of RHCP and LHCP polarization that will be fully received and processed by the satellite. Consequently, all the interference power will be received by the satellite and there will not be any polarization discrimination as claimed by 5A/727. This error results in a noise reduction equivalent to 3 dB.

Additional Issue: Comparison with Other Sharing Studies in the US Contribution

The US Contribution to WP5A contains not only the US Sharing Study, but also a compilation of the ITU-R WP5A sharing studies and analyses contributed by France, Japan, China, Russia, and Globalstar. While only the Globalstar Sharing Study[40] contained in the US Contribution specifically addresses the impact of outdoor U-NII-1 emitters in the US, only the US Sharing Study concludes that sharing between access points operating between 5150-5250 MHz and Globalstar's feeder uplink is possible. All the other studies conclude that the ITU-R recommendations for interference to satellite uplinks will be exceeded. The US Sharing Study fails to explain why its conclusion differs

[34] US Sharing Study, section 5.1.1.3.2.5, page 31, Figure 7.
[35] US Sharing Study, section 5.1.1.3.2.5, page 32, Table 9, Ratio of overlapping RLAN.
[36] Roberson Analysis, Appendix C, page 61, Figure 29.
[37] US Sharing Study, section 5.1.1.3.2.4, page 23, Equation 3.
[38] US Sharing Study, section 5.1.1.3.2.4, page 23, Equation 3.
[39] See for example: R. Galuscak and P. Hazdra, Circular Polarization and Polarization Losses, Figure 6 on page 8; http://www.attplus.cz/hamradio/projekty/article/cppl_b.pdf.
[40] See 2018 Globalstar Sharing Contribution.

not only from the other sharing studies, but also why it is not consistent with Globalstar's noise rise measurements contained in ITU-R WP5A Contribution.[41]

7. Inclusion of WISPs

In its Comments WISPA asserts that because Globalstar previously indicated that wireless Internet service providers' (WISPs') outdoor, fixed point-to-point operations in the U-NII-1 band have not materially contributed to the noise floor rise, an NOI should not include consideration of these point-to-point facilities.[42] We address this issue below.

While the Roberson Analysis attached to the Petition stated that it was highly unlikely that current WISP point-to-point deployments have contributed materially to the measured noise rise, neither Globalstar nor the Roberson Analysis have indicated that WISP operations could not become a material contributor to the noise rise in the future.

In fact, it is essential that all categories of unlicensed uses, including WISP fixed point-to-point operations, be considered in the NOI. The inclusion of point-to-point operations in this process is actually supported by the Petition in the Roberson Analysis. There, Roberson analyzed two unlicensed interference scenarios. In the first scenario, described in the Roberson Analysis at pages 15-24, outdoor U-NII-1 transmitters with three different antenna types were included in an assessment of the impact of outdoor U-NII-1 operations on the noise floor at 5096-5250 MHz. The second scenario, described at pages 24-32 of the Roberson Analysis, considered only emitters with omni-directional antennas.

In the first scenario, emitters with highly directional antennas were selected to model fixed point-to-point links like those utilized by WISPs. As shown in the Roberson Analysis, a combination of fixed point-to-point links, omni-directional antennas, and directional panel antennas – all deployed outdoors – will produce a substantial, harmful noise floor rise in Globalstar's feeder uplink spectrum, assuming a reasonable quantity of transmitters and realistic operational parameters. In particular, if deployed in sufficient numbers, outdoor fixed point-to-point systems will be a material contributor to this noise floor rise. Analysis shows that on an individual basis, point-to-point emitters can generate more interference to Globalstar than omni-directional access points.[43] Accordingly, the Commission's NOI should seek factual information about the relative deployment numbers and operational characteristics of outdoor fixed point-to-point facilities at U-NII-1, along with information on other emitter types.

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[41] See 2018 Globalstar Measurements Contribution.

[42] Comments of the Wireless Internet and Service Providers Association, RM-11808, July 6,2018. (WISPA Comments).

[43] Roberson Analysis, section 4.1.2, Table 2, page 18. The interference power flux density at the satellite from directional high gain dish antennas used by point-to-point links is 7 dB higher than omni-directional stick antennas typically deployed by APs. The tabulated numbers are average power flux densities per AP device.

8. Conclusion

The analysis of opposition to Globalstar's Petition for an NOI reveals that opponents provide no physical, empirical data or technical analysis of Globalstar's satellite measurements demonstrating that the noise rise in Globalstar's feeder uplinks is not real. Similarly, opponents to an NOI present no evidence that the noise rise does not originate in the U-NII-1 band. Opponents forecast an intensified utilization of U-NII-1 by unlicensed operations, which will elevate the noise floor at 5.1 GHz beyond the 2 dB level now being measured. Without Commission action, this future noise floor rise will result in harmful aggregate interference to Globalstar's MSS operations and its public safety users and other customers.

Appendix A: Company Profile

Profile: Roberson and Associates, LLC

Roberson and Associates, LLC, is a technology and management consulting company with government and commercial customers that provides services in the areas of RF spectrum management, RF measurements and analysis, and technology management. The organization was founded in 2008 and is composed of a select group of individuals with corporate and academic backgrounds from Motorola, Bell Labs, IBM, IITRI (now Alion), independent consulting firms, and the Illinois Institute of Technology. Together the organization has over 400 years of the high technology management and technical leadership experience with a strong telecommunications focus.

Profiles: Roberson and Associates, LLC, Staff

Dennis A. Roberson, President and CEO, Roberson and Associates

Mr. Roberson is the Founder, President and CEO of Roberson and Associates, LLC. In parallel with this role he serves as Vice Provost for Research and Research Professor in Computer Science at Illinois Institute of Technology where he has responsibility for IIT's corporate relationships including IIT's Career Management Center, Office of Compliance and Proposal Development, Office of Sponsored Research and Programs, and Technology Transfer efforts. He also supports the development and implementation of IIT's Strategic Plan, the development of new research centers, and the successful initiation and growth of IIT related technology-based business ventures. He is an active researcher in the wireless networking arena and is a co- founder of IIT's Wireless Network and Communications Research Center (WiNCom). His specific research focus areas include dynamic spectrum access networks, spectrum occupancy measurement and spectrum management, and wireless interference and its mitigation and of which are important to the Roberson and Associates mission. He currently serves on the governing and / or advisory boards of several technology-based companies. Prior to IIT, he was EVP and CTO at Motorola and he had an extensive corporate career including major business and technology responsibilities at IBM, DEC (now part of HP), AT&T, and NCR. He is and has been involved with a wide variety of Technology, Cultural, Educational and Youth organizations currently including the Federal Communications Commission Technical Advisory Council and Open Internet Advisory Committee, the Commerce Spectrum Advisory Committee, and the National Advisory Board for the Boy Scouts of America and its Information Delivery Committee, and the Board of HCJB Global. He is a frequent speaker at universities, companies, technical workshops, and conferences around the globe. Professor Roberson has BS degrees in Electrical Engineering and in Physics from Washington State University and a MSEE degree from Stanford.

Kenneth J. Zdunek, Ph.D. –V.P. and Chief Technology Officer

Dr. Zdunek is Vice President and the Chief Technology Officer of Roberson and Associates. He has 35 years of experience in wireless communications and public safety systems. Concurrently he is a research faculty member in Electrical Engineering at the Illinois Institute of Technology, in Chicago, Illinois, where he conducts research in the area of dynamic spectrum access and efficient spectrum utilization, and teaches a graduate course in wireless communication system design. He is a Fellow of the IEEE, recognized for his leadership in integrating voice and data in wireless networks. Prior

to joining Roberson and Associates, he was VP of Networks Research at Motorola, a position he held for 9 years. Dr. Zdunek was awarded Motorola's patent of the year award in 2002 for a voice-data integration approach that is licensed and extensively used in GSM GPRS. He holds 17 other patents, included patents used in public safety trunked systems and cellular and trunked systems roaming. He directed the invention and validation of Nextel's iDEN™ voice-data air interface and IP based roaming approach, and was the principal architect of Motorola's SmartNet™ public safety trunking protocol suite. In the 1990's, he directed a Spectrum Utilization and Public Safety Spectrum Needs Projection submitted to the FCC in support of the 700 MHz spectrum allocation for Public Safety. He was awarded the BSEE and MSEE degrees from Northwestern University, and the Ph.D. EE degree from the Illinois Institute of Technology. He is past president, and on the board of directors of the Chicago Public Schools Student Science Fair, Inc.

Alan Wilson, Principal Engineer III

Mr. Wilson joined Roberson and Associates in 2016 and has 40 years' experience in the Telecommunications industry. Mr. Wilson worked at Motorola to develop the Astro product line that supports the Project 25 radio standards suite. This became a $6 billion business for Motorola that has continued to diversify beyond the original market for public safety and mission-critical radios. Mr. Wilson authored dozens of standards for the P25 standards suite that were published by the Telecommunications Industry Association (TIA). He moved to Tyco Electronics and later Harris Corporation to continue to work on P25 standards for Phase 2 to double the spectrum efficiency with Time Division Multiplexing Access (TDMA). After the launch of Phase 2, Mr. Wilson chaired the wide band data committee to begin working on the Mission Critical Push to Talk (PTT) standards for 3G PTT and Long Term Evolution (LTE) through a joint project with Alliance of Telecommunications Industry Solutions (ATIS). The joint project is known as Joint Land Mobile Radio Long Term Evolution (JLMRLTE), and it intends to interconnect private Land Mobile Radio (LMR) radio systems with LTE telephone systems to provide encrypted digital voice and data services across networks. Mr. Wilson has been an inventor on 27 patents and an author of several publications by the Telecommunications Industry Association (TIA) and Project 25 Technology Interest Group. Mr. Wilson earned his Bachelor of Science in Electrical Engineering from Massachusetts Institute of Technology a Master of Science in Electrical Engineering from Illinois Institute of Technology.